VERIFICATION OF A TRANSLATION

I, Antonella Fusillo, resident of the United States, residing at 28-32 45th Street, # 2F, Astoria, N.Y. 11103, depose and state that:

1. I am familiar with the English and German languages.

2. I have read the attached German Search report regarding German patent application no. 198 08 145.6.

3. The hereto attached English language text is an accurate translation thereof.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Antonella Fusillo

Date: May 17, 2000

PROCESS FOR INJECTION MOLDING, INJECTION MOLD AND INJECTION MOLDING DEVICE, AS WELL AS PROCESS FOR FILLING A MAIN EXTRUDER FROM A SECONDARY EXTRUDER

Background of the Invention

The invention relates to a process for injection molding of injection molded parts from plasticizeable material, wherein a first plasticizeable material is injected into the hollow of an injection mold, and subsequently another plasticized material is injected into the hollow, as well as to an injection mold and an injection molding device with a plasticizer unit and an injection unit.

Processes of this type are known under the term "mono-sandwich process" and "two-component process".

The mono-sandwich process includes initially injecting into an injection mold, for example, a particularly pure plasticized material which hardens on the wall surface of the injection mold, and subsequently injecting a filler which forms the core of the injection molded part and generally contains inferior materials. This makes it possible, at low materials costs, in particular when using recycled materials, to produce injection molded parts with surfaces that are formed entirely from high-grade materials.

In order to produce injection molded parts with elements of various materials, the two-component process is used which includes various injection

units for introducing plasticizeable materials into the injection mold at various locations, so that, for example, a toothbrush can be made with areas of hard plastic and a flexible intermediate area of softer plastic. The two-component process requires, however, a very complicated injection molding device so that the production process becomes relatively expensive.

A SUMMARY OF THE INVENTION

In view of the known prior art, it is an object of the invention to propose a simple injection molding process for making injection molded parts from various materials.

This object is attained in accordance with a generic process by so introducing a first plasticized material into the hollow as to wet only a partial area of the wall surface of the hollow, and by subsequently so introducing another plasticized material into the hollow as to wet at least a part of the remaining area of the wall surface of the hollow.

According to the process of the invention, part of the hollow is kept initially inaccessible, or such a small quantity of the first plasticizeable material is injected that only part of the wall surface of the hollow is wetted. Subsequently at least one further material is introduced into the then cleared remaining hollow to harden in the remaining area of the wall surface of the hollow, so that the finished injection molded part comprises an exterior surface made of various materials.

The process allows the use of a modified conventional mono-sandwich injection molding machine, whereby, in contrast to current conventional processes, particular regard is directed to the fact that the second material is not completely enveloped by the first material. In particular, when the second material is also a high-grade material, the process according to the invention permits the production of injection molded parts from various materials which cannot be distinguished from conventional injection molded parts made by the two-component process.

According to a preferred variation, the first plasticized material and at least one other plasticized material are injected into the hollow through the same opening. A single opening in the injection mold for various materials results in lower production costs for the injection molding device and permits a simple process control as the individual materials are injected in succession into the injection mold at the same location. Exact dosage and filling times realize outstanding production results at most different injection molded parts.

Since the transition area of the injection molded part between the partial area and the remaining area of the wall surface oftentimes forms in practice an irregular or blurred line, it is proposed to introduce only so much first material into the injection mold that after injection of the other material, the first material extends up to a shoulder in the hollow between the partial area and the remaining area. The shoulder may be a random edge which preferably projects

from the wall surface into the interior of the hollow and forms a barrier against continuous flow of the first plasticized material into the area of the shoulder.

As an alternative, or in addition to. the described process, after injection of the first material a slide gate can be moved to clear at least part of the remaining area. The term "slide gate" will refer to either a valve-like element which clears a channel to a partial area of the hollow in the injection mold. This allows directing the flow of the plasticized material from a single injection point via various channels into various partial areas of the hollow. However, the slide gate can also be designed as a plunger which, when pushed into a partial area of the hollow in the injection mold, covers a partial area of the wall surface of the hollow. When the slide gate is retracted, at least part of the remaining area of the wall surface of the hollow is cleared, so that the other plasticized material wets the wall surface of the hollow in this area.

Beyond the use of various plasticizeable materials, hollow injection molded parts can also be produced when a gas space is formed in the injection mold during the injection molding process. Such a gas space is realized by injecting a gas during the injection molding process. Cavities may also be formed in a way that a material quantity is stretched into an empty space of the hollow (injection blow molding) to thereby allow cost-efficient production of two-component injection blow molded parts which contain a hollow. The hollow may remain under constant gas pressure.

A great number of particularly advantageous applications can be implemented when one plasticized material is a relatively soft or rubber-like material, and at least one other plasticized material is a relatively hard material. Whereas the soft or rubber-like material can assume the function of a seal, a tire or a handle, the relatively hard material serves for the creation of a solid base body.

Particular effects can also be realized when the plasticizeable materials exhibit at least two different colors or are transparent. While the various colors create optical effects, it is also possible to produce injection molded parts with colored and transparent areas which for example can be used as a cover with a transparent window. In particular, transparent injection molded parts, which are dyed in partial areas to avoid transparency, can be realized by the described process in a particularly cost-efficient manner.

In addition, it is advantageous for various applications when at least one plasticized material includes gas pockets. Gas pockets reduce weight and material use and may offer other specific advantages, depending on the purpose of use.

For example, to use recycling particles, it is proposed that at least one plasticized material includes pockets of another component. Thus, it is possible to admix, for example, elastomeric recycling particles to a soft material, to adjust

the hardness of the material.

The above-described process is also capable to combine a biodegradable material with other materials, in particular with other biodegradable materials. In this case, a material mixture can be realized, on the one hand, and the various materials can be injected also as first and second materials, on the other hand. This combination opens up completely new options as the biodegradable material can be enveloped, for example, by a protective layer. In particular, this protective layer can be made resistant over a period or under certain circumstances. For example, material that can be degraded by water may be enveloped by a layer that can be degraded by microorganisms or by UV light, thereby realizing a water-resistant part which still can be degraded rapidly after degrading the outer layer. It will be understood that the combination of a biodegradable material is advantageous per se.

Especially suitable for carrying out the process according to the invention is an injection mold which has at least one sensor disposed at the transition between the partial area and the remaining area of the wall surface of the hollow in the injection mold. Such sensors permit, for example by means of pressure gauges, temperature gauges or ultrasound measuring devices, to ascertain when a particular plasticized material reaches the location on the wall surface where the sensor is located. In this manner, the injection process can be accurately monitored and controlled.

In particular, it is possible to arrange such a sensor in an ejection bore of the mold. For example, the sensor may be an ultrasonic sensor for use as quality assurance. By utilizing an ejection bore, the sensor can easily be attached because suitable ejection bores are provided anyway and the provision of only a further respective bore is required. Also, an existing bore, in particular when existing molds are involved, can be used.

It will be understood that any kind of bore may be referred to in the ejection block so long as it reaches the workpiece. The bore may be closed on the side of the mold. Still it is possible to very easily position a sensor in immediate proximity of the workpiece by means of this bore.

It is advantageous to provide an injection molding device, which is especially useful for the process according to the invention, with a shoulder at the transition between the partial area and the remaining area of the wall surface of the hollow in the injection mold. This shoulder, permits, as stated above, to create a straight transition line between the components.

During hot-runner injection molding, a two-component mixture remains in the hot runner of the injection mold and may reach during injection of a further part, the hollow of the injection mold. This would, however, lead to a contamination of the outer layer of the next injection molded part. It is therefore proposed that the injection mold includes a hot runner with a by-pass device

which permits plasticized material that flows to the hollow to flow into an overflow. After the first injection molding operation, the by-pass device diverts oncoming material into the overflow until pure material reaches the runner. Thus, contaminations can be collected in the overflow for subsequent disposal. Material collected in the overflow may also further be utilized, for example, to subsequently purposely seal a gas hole in proximity of the overflow. This may be implemented by a plunger which conveys melt from the overflow.

Also proposed is an injection molding device with a plasticizer unit and an injection unit, which includes at least two secondary extruders arranged between screw tip and nozzle tip. The use of several secondary extruders permits sequential introduction of various materials into the injection mold to produce injection molded parts from most different materials by using the process according to the invention.

In addition, an injection molding device is proposed which includes at least one injection unit having an injection piston by which melt is injected from a melt compartment, and at least two extruders connected to this melt compartment. Such an arrangement is capable to injection-mold extremely small workpieces and to use thereby also very sensitive melts. In particular, it is possible, to charge the melt compartment with two different melts according to the FIFO (first in, first out) principle, and to produce in this manner precision components from various materials or to execute micro injection molding with two different materials.

An injection molding device including a main extruder, which includes a melt compartment from which a nozzle extends via a hot runner, and a secondary extruder can be operated in an especially simple manner by transferring melt from the secondary extruder from the melt compartment, when a second channel, connected to the secondary extruder, is added to the melt compartment via a control unit which is coupled with the movement of the secondary extruder.

Such a coupling may be implemented, for example in a simple manner, by a rigid connection between control device and secondary extruder. On the other hand, spring elements may be provided. Moreover, it is also conceivable to actively operate the control device through control via a pneumatic or hydraulic mechanism in dependence on the movement of the plasticizer unit.

The control unit may include an adjustment nozzle which bears upon a surface, preferably a surface of the secondary extruder, and is secured with a flange. Such an adjustment nozzle ensures, regardless of other features of the injection molding device, an extremely simple construction and an extremely simple replacement of the adjustment nozzle.

It is also secondary to what extent this nozzle has incorporated therein hot runners or only feed channels.

Furthermore, the hot runner may include a pressure-dependent valve. In such an arrangement, the flow conduction control of the hot runner via the movement of the secondary extruder may be omitted. Flow conduction is then controlled pressure-dependent. When melt is transferred from the secondary extruder to the main extruder at low pressure, such a pressure valve will not yet respond. Only when the pressure reaches the level during injection molding through the main extruder will the valve respond. In this manner, the injection molding process can further be simplified. Such a pressure-dependent valve is also useable in an advantageous manner, regardless of the remaining features of the injection molding device.

The control unit may, on the other hand, include two partial channels which open or close the hot runner or feed channel depending on the position of the control unit. In this manner, a simple control of the control unit is realized in dependence on the movement of the secondary extruder.

In particular, it is possible to so construct one of the partial channels that it closes the second channel from the secondary extruder to the main extruder when the secondary extruder has reached its transport position to convey melt to the main extruder.

The control unit may include a partial channel block which accommodates the partial channels and is guided in a block guide, thereby ensuring a reliable

flow control. For example, the above-described adjustment nozzle may be conceivable as partial channel block. Also other devices, such as plates having partial channels are conceivable as partial channel block. The partial channel block may, as described above, be connected with the secondary extruder or activated independently therefrom.

A particular simple construction can be implemented when the block guide accommodates a hot runner. In this manner, the partial channel block may then be so shifted that, on the one hand, one partial channel opens the hot runner and, on the other hand, the other partial channel - when the partial channel block occupies the respective position - opens the pathway between secondary extruder and hot runner or main extruder.

Furthermore, an injection molding device is proposed which includes a main extruder, movable between an injection position and an idle position along a path, and at least one secondary extruder which includes a control unit, disposed between the injection position and the idle position, with the control unit including a channel with an inlet and an outlet and swingable between a charging position and a release position, wherein in the charging position the inlet points to the secondary extruder and the outlet points to the main extruder, and wherein in the release position the pathway for the main extruder is cleared. When rigidly connecting the inlet with the secondary extruder, the above-stated coupled

movement between control unit and secondary extruder is carried out directly. However, other linkages are certainly also conceivable.

Such a swingable control unit is capable to significantly accelerate and facilitate the process cycle of the above-described process as well as of other processes, also regardless of the coupled movement with the secondary extruder, as a conjoint movement of the secondary extruder or extruders with the main extruder is no longer required. Rather, the secondary extruders as well as the control unit are appropriately controlled in dependence on the respective process stage. When the main extruder is in its idle position, the control unit occupies its charging position, and the secondary extruder and the main extruder are connected to the inlet and outlet, respectively, of the control unit. The main extruder can then be charged by the secondary extruder. After charging, the secondary extruder is removed from the inlet and the control unit is swung away to clear the path for the main extruder.

The above-described arrangement is very compact when the inlet and the outlet of the control unit define an acute angle relative to one another. Such an arrangement permits disposition of the control unit immediately in front of a nozzle plate of the injection molding device, as no additional space is required in this location for the secondary extruder which projects approximately in a V-shaped manner from the main extruder. In this way, the pathway to be traveled

by the main extruder can be minimized so that the overall time for the injection molding process can be reduced.

It will be understood that such a V-shaped disposition of main extruder and secondary extruder is already advantageous to reduce the required structural space and thus the pathway to be traveled by the main extruder.

Furthermore, an injection molding device is proposed including a main extruder movable between an injection position and an idle position along a path and traversing with a nozzle in its injection position a nozzle plate and at least a portion of an adapter plate through an injection opening, and a secondary extruder which is displaceable between a charging position and a release position, whereby the path of the injection device is cleared in the release position and an outlet of the secondary extruder points in the charging position to the nozzle of the main extruder, with this outlet being disposed in an opening of the adapter plate which terminates in the injection opening. The opening of the adapter plate may terminate in the injection opening at an angle of 90°, on the one hand, or also at an acute angle, on the other hand.

It is also conceivable, to provide the opening for the secondary extruder in the nozzle plate. In particular when the adapter plate is absent is this of advantage, whereby the outlet of the secondary extruder is arranged in the

charging position in an opening of the nozzle plate which is aligned with the injection opening.

Through the above-described measure, the position which the main extruder should occupy when being filled with melt by the secondary extruder, can be shifted to a location immediately proximate of the mold, up into the mold space. In this manner, the pathway to be traveled by the main extruder is minimized when being retracted for clearing the outlet, so that the overall time for the injection process is reduced.

The secondary extruder may be supported on the outlet side at least in its charging position by a force applied by the main extruder. This may implemented by a guide in the adapter plate or by a lug engaging the adapter plate. In this way, a correct seat of the main extruder upon the outlet of the secondary extruder is ensured during charging of the main extruder from the secondary extruder. Furthermore, there is no need to construct the secondary extruder in a particularly stable fashion as the above-described support provides for a sufficient stability. This arrangement also enable in particular to use known secondary extruders and to provide them with a respective extension piece so that this embodiment can be realized in a comparably cost-efficient manner.

Finally, the invention proposes a process for charging a main extruder of an injection molding device with a melt from a secondary extruder, with the melt

being filled in the main extruder through a feed channel in a hot runner which is connected to the main extruder, on the one hand, and terminates in a mold, on the other hand, whereby the injection process is so controlled as to leave a sprue of solidified or solidifying workpiece in the hot runner between mold and the location where the feed channel terminates in the hot runner, until the main extruder is filled with the melt.

This ensures that melt does not flow inadvertently from the secondary extruder in the direction of the workpiece, but reaches the main extruder. As soon as the main extruder is accordingly filled, the workpiece can be ejected.

As a consequence of the above-described process, the use of a valve in the hot runner can be omitted.

Advantageously, the sprue extends to immediately the area where the feed channel terminates in the hot runner.

A BRIEF DESCRIPTION OF THE DRAWING

The process according to the invention and various exemplified embodiments for applying the process according to the invention are explained in more detail with reference to the drawing, in which:

FIG. 1 is a schematic three-dimensional view of an injection molding device with mold;

FIG. 2 is a sectional cutaway view from FIG. 1;

FIG. 3 is a schematic sectional view of an alternative embodiment of an injection molding device;

FIG. 4 is a sectional view through a cap component;

FIG. 5 is a detail, on an enlarged scale, of FIG. 4;

FIG. 6 is a sectional view through a further cap component;

FIG. 7 is a sectional view through a caster component;

FIG. 8 is a sectional view through a part of the caster component according to FIG. 7, illustrating an embodiment with profile;

FIG. 9 is a sectional cutaway view of the caster component according to Fig. 7, illustrating an interlocking tire connection;

FIG. 10 is a sectional cutaway view of the caster component according to Fig. 7, illustrating a gas-filled tire component;

FIG. 11 is a sectional cutaway view of the caster component

according to Fig. 7, illustrating a tire component injected from the direction of the hub;

FIG. 12 is a sectional view through a caster component with ball caster;

FIG. 13 is a sectional view through a handle;

FIG. 14 is an illustration of a brush handle;

FIG. 15 is a sectional view through a housing having an upper part accommodating a schematically depicted seal and a lower part accommodating a schematically depicted seal in the cap part and cable feedthrough;

FIG. 16 is a sectional view through a screwed cable connection;

FIG. 17 is an illustration of a first embodiment of a bottle closure;

FIG. 18 is a sectional view through another embodiment of a bottle closure;

FIG. 19 is an injection molding device with mold;

FIG. 20 is a cutaway view from FIG. 19 with a hot runner for hot runner injection molding;

FIG. 21 is a schematic illustration of a further injection molding device;

FIG. 22 is a perspective illustration of a hot runner block with adjustment nozzle as control unit;

FIG. 23 is a sectional view through the adjustment nozzle according to FIG. 4;

FIG. 24 is a schematic sectional view through a further control unit;

FIG. 25 is a schematic illustration of a pivoting nozzle serving as control unit; and

FIG. 26 is a schematic illustration of a further injection molding device.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The injection molding device 1 shown in FIG. 1 includes a nozzle 2 which is connected to a mold 3. Disposed on the other side of the nozzle are two secondary extruders 4 and 5 which are placed upon the main extruder 6. Both

secondary extruders have feed hoppers 7 and 8, and the main extruder has a feed hopper 9.

The mold 3 has a first inlet 10 for plasticized components and a second inlet 11 for a gas to form a hollow in the injection molded part. In addition, a slide gate 12 is provided in the mold 3. This slide gate 12 ensures that initially only a partial area of the wall surface of the hollow in the mold cavity is wetted with plasticized material, and that a remaining area of the wall surface of the hollow is only wetted with plasticized material after the slide gate 12 has been drawn. Thus, the cavity of the mold is subdivided into a partial area and a remaining area, with the remaining area being cleared only after the slide gate 12 has been drawn.

FIG. 2 is a sectional view of that part of the injection molding device 1 which is adjacent to the nozzle 2. Adjoining the nozzle 2 is a partial area with a first plasticized material 13 which is supplied via the feed hopper 7 and the secondary extruder 4. Then follows a further area which is supplied with a second plasticized material 14 via the hopper 8 and the secondary extruder 5. The remaining area of the injection molding device 1 is filled with a third plasticized material 15 supplied via the funnel 9 and conveyed in the main extruder 6 by means of a screw 16.

This enables to sequentially introduce different plasticized materials 13,

14, 15, into the mold 3 via the nozzle 2. Preferably, the slide gate 12 is drawn when changing from one material to the other material, to wet a partial area of the wall surface of the hollow of the mold with another plasticized material.

FIG. 3 shows another injection molding device according to the invention. Here, extruders 21, 22 and 23, 24 are arranged respectively on two sides of a mold 20. The extruders 21 and 22 feed plasticizeable material to a channel 25 which leads to an opening 26 in the mold 20, and the extruders 23 and 24 feed plasticized material to a channel 27 which leads to an opening 28 in the mold 20.

To operate the device, plasticized material can either be initially fed to the cavity 29 of the mold 20 by the extruder 21, whereupon subsequently another plasticized material is fed to the cavity 29 by the extruder 22. Alternatively, it is also possible to initially push plasticized material into extruder 22 by means of extruder 21, whereupon thereafter the extruder 22 feeds first the plasticized material originating from extruder 21 into the cavity 29, and subsequently the extruder 22 conveys readied plasticized material. Of course, the same process variants are also possible with extruders 23 and 24, although the process according to the invention can be carried out also solely with the extruders 21 and 22.

The channel 30 connects the extruders 23 and 24 with the extruders 21 and 22, optionally assisted by an interposed pump 31, so that it is possible to

feed four different plasticized materials at the opening 26 or the opening 28 in succession into the cavity 29 of the mold 20. For sake of clarity, the respectively required slide gates have not been illustrated. However, the artisan readily recognizes that the device according to FIG. 3 enables introduction of four different materials through one opening 26 or 28 into the cavity 29, and that the device allows various process control methods as a result of installed slide gates.

Thus, it is, for example, possible to produce with a device according to FIG. 1 or 3, the cap component 40 shown in Fig. 4. Hereby, a harder material 42 is initially injected at sprue 41 into an injection mold and hardens at the walls of the mold. Subsequently, a slide gate is drawn to clear an opening in the areas 43, 44 so that softer material 45 conveyed at sprue 41 flows in the cavity of the mold up to the space cleared by the slide gate, to form a protruding seal 46.

Thus, the cap 40 has an envelope of harder material 42 with a subjacent softer material 45 which is visible only in the marginal area of the cap 40 as ring-shaped seal 46.

The sprue area, shown on an enlarged scale in FIG. 5, depicts the harder plasticized material 42, which hardens at the wall surfaces of the cavity, and the softer material 45 conveyed at point 41 flows into the mold in the central area between the wall surfaces of the cavity.

FIG. 6 shows an alternative embodiment for making a cap by the process according to the invention. The cap component 50 shown there includes an arched cap part 51 which is initially injection-molded via a channel 52 from the direction of the mold inlet 53. Subsequently, the slide gate 54 is so repositioned that softer material flowing from the opening 53 enters a sealing area 57 cleared by a slide gate via the channels 55 and 56, to form a ring-shaped seal 58 which is fixedly secured to the arched cap component 51 of harder material.

Instead of, or in addition to, the use of a slide gate, a shoulder 59 (compare FIG. 4) may be provided in the mold at the transition point between the materials, to ensure that the first plasticized material flows only up to this shoulder, and only the second plasticized material is able to flow beyond this shoulder. Such a shoulder 59 extends in FIG. 4 transversely to the flow direction, with a further shoulder 60 arranged in opposite disposition. As a result, the hard component 42 flows only to the shoulders 59 and 60 and hardens at the margin of the mold. The subsequently flowing material 45 is no longer retarded by the shoulders 59 and 60 because the external plasticized material 52 has already hardened up to the inner edge of the shoulder, so that the subsequently flowing material 45 flows beyond the shoulder and wets the remaining area of the wall surface of the hollow.

FIGS. 7 to 11 show a caster component 70 with various configurations of a radially outwardly positioned tire 71 to 75. In its basic version, the caster

component 70 includes a hub 76 and a radially adjacent tire 71. The mold provided for injection molding this component has an inlet 77, which leads to a channel 78, to injection-mold the hub part 76 from a harder material. Subsequently, a slide gate 79, arranged between the inlet 77 and the channel 78, is so repositioned that softer material streams via the channel 80 into the radially outwardly located region of the hub 76, to form a tire 71.

The modified embodiment according to FIG. 8 provides a profile in the tire 72. According to FIG. 9, the tire 73 is connected to the hub component 76 by an interlocking connection 81. FIG. 10 shows the inclusion of a gas into the tire part to achieve a "balloon effect" by means of an air bubble 82. Lastly, the exemplified embodiment according to FIG. 11 shows an alternative way of making the tire by injecting the softer tire component via the channel 78 subsequent to injecting the harder component, so that, like in the case of the cap component according to FIG. 4, the softer component flows through the center of the harder component and forms a tire 75 radially on the outside. Also in this case, either a slide gate, which clears a remaining area of the cavity, or a shoulder, which inhibits the flow of the first component, can be applied.

FIG. 12 shows a further caster component, also called a ball caster 90. Hereby, a hard component is initially injected into the mold via an annular sprue 91, and subsequently a soft component is injected via the sprues 92 and 93. Like the cap component according to FIG. 4, this component, too, can be

made with two different materials injected in succession at sprue 91. The hardness of the soft component 94 can be adjusted by admixing elastomeric recycling particles.

FIG. 13 shows a handle 100 which includes a handle body 101 and a handle shell 102, with a gas bubble 103 preferably provided in the handle body. The handle body is made from a harder material through injection via the inlet 104 and the handle shell is made from a foamed material through injection via the inlet 105. Optionally, soft components, for example for door handles or as handbrake levers as well as for pedals, can be injected from inside.

FIG. 14 shows a brush handle 110 which is made by injecting initially a soft component 111 via the sprue 112 and subsequently by injecting a hard component 114 via the sprue 113. Of course, the various materials 111 and 114, like in the other exemplified embodiments, may also have, additionally or alternatively, various colors or include plasticizeable materials of various properties in some other way. In particular, any kind of handles, flatware, for example for camping with soft handle, designer flatware, toothbrushes or tool handles, may be made through this process. Through combination with a gas bubble, also two-component hollow parts can, for example, be made, especially handles or the like.

The manufacture of a housing 120, as shown in FIG. 15, is a further

frequent application of the process described herein. As shown by the schematic illustration of FIG. 15, this housing has in the upper part of the drawing a seal 121 which is located in the housing part, and in the lower part of the figure a seal 123 which is arranged in a matching cap part 122 and interacts with a complementarily shaped counterpart 124 in the housing 120. This housing can be made analogous to the previously described cap according to the process shown in FIGS. 4 and 6. An advantageous configuration of the housing shows a cable feedthrough 125 which has a ring 126 of a softer plastic material.

FIG. 16 shows a screwed cable connection 130 with a claw-shaped strain relief 131 and a seal 132. In this embodiment, a harder component 134 is initially injected through mold inlet 133 to form the body of the screwed cable connection 130 and the claws of the strain relief 131. Subsequently, the slide gate 135 is so repositioned that in addition to the central channel 136, two further channels 137 and 138 are cleared so that subsequently flowing softer material can flow into a region cleared by a slide gate (not shown), to form the seal 132. At the same time, a partial stream of the softer material in the central channel 136 flows to the strain relief 131 to form also there a body 139 of softer material.

While in the upper part of FIG. 16, the claws of the strain relief 131 are shown in their uncompressed state, the lower part of FIG. 16 shows how the claws of the strain relief 131 are compressed by means of a screwed-on

clamping nut 140.

It will be appreciated that a number of electric articles or auxiliary electric articles can be made in this fashion.

FIG. 17 shows a bottle closure 150 as a further embodiment. This bottle closure is made from a harder component 151, which forms the base body, and a softer component 152, which protrudes in the form of a ring in a certain region and acts as a seal. A gas bubble 153 is provided within the harder component 151 to save material and to attain a higher flexibility of the bottle closure. The closure may also be constructed of solid configuration.

FIG. 18 shows a further bottle closure 160. This bottle closure includes a hard inner part 161 which is surrounded by a softer material 162, whereby it is also possible to reverse the type of materials. The inner part 161 includes ribs 165 which extend, preferably, from a central axis 163 to a ring body 164.

The process according to the invention can be used for numerous further applications such as wheels made of hard and soft components, to children's toys made of differently colored components, joints of hard and soft components up to caps having opaque and transparent zones. Further examples include: screwdriver handles, hangers with anti-slip edges, shock absorbers, buffers, silent blocs, furniture hardware, buttons or shoe soles. Also parts can, for

example, be made of which at least one material component are antistick or hydrophobic. This component is then quasi self-cleaning and could be used, for example, for shoe soles, in particular shoe soles with cleats. Important areas of application include moreover transport belts, transport drums and transport rollers.

FIGS. 19 and 20 show the use of a mold with a special hot runner. When injecting two different materials 170, 171 with an injection unit 172 into a mold 173, several materials 170, 171 are fed in succession into the mold 173. Thereby, an outer ring made from the first component 170 forms in the hot runner and accommodates as a core the further component 172. After conclusion of the injection process with the component 171, it is however necessary to again feed new component 170 which, normally, pushes the remaining residue of the second component 171 in the hot runner 174 as contamination into the cavity.

FIG. 20 shows an overflow 175 and a slide gate 176 in the hot runner 174 to avoid such contamination. The slide gate 176 enables to press the remainder of the second component 171 with subsequently fed first component 170 into the overflow 175 and to clear the cavity 177 only when first material is again provided at the slide gate 176. Thus, the use of a sprue rod is no longer necessary.

FIG. 21 illustrates an injection molding device which includes an injection unit with an injection piston 201 for injecting melt from a melt compartment 202.

Two extruders 203 and 204 fill the melt compartment 202 with melt. The injection piston 201 is driven by an injection cylinder 205. Particularly fine precision components can be made with such an arrangement. This arrangement is especially suitable for micro injection molding with two different starting materials.

The connection between the extruders 203 and 204 may be ensured, on the one hand, via valves. It is, however, also possible to ensure a desired filling of the melt compartment 202 through appropriate selection and control of the melt streams flowing during filling.

FIG. 22 shows a hot runner block 230 which interacts with a particular adjustment nozzle 231. This adjustment nozzle 231 is secured to a secondary extruder 263 by a flange. In this manner, the adjustment nozzle 231 can very easily be positioned. When adjusting the adjustment nozzle, in particular the distance of the nozzle end will not change, as is the case with threadably engaged conventional adjustment nozzles.

The hot runner block 230 has a through channel 232 and a round central opening 233 which intersects the channel 232 for receiving the adjustment nozzle 231. This nozzle 231 has a bore 234 which extends transversely to the nozzle axis, with the bore corresponding to the diameter of the channel 232 and aligned with the channel 232 through counterboring the adjustment nozzle in the opening 233 of the hot runner block 230.

Above the bore 234, the adjustment nozzle 231 is provided with a L-shaped bore 235 which should also be aligned with the channel 232 and then connects the secondary extruder 236 with the channel 232 to convey plasticizeable material from the secondary extruder 236 through the L-shaped channel 235 into the channel 232.

The channel 232 is further in communication with a main extruder 237.

The adjustment nozzle 231 thus operates as control unit to provide a flow path between the main extruder 237 and the secondary extruder 236 and workpiece. It will be understood that such an adjustment nozzle 231 is also advantageous for other control units.

Furthermore, the flange-mounting can advantageously be used, regardless of other features of the adjustment nozzle 231, for any kind of nozzles which should be precisely adjusted.

Another control unit is shown in FIG. 24 and includes a hot runner 241 for conducting melt from a main extruder to a mold nest (as indicated by the arrow 246). Branching off from this hot runner 241 is a partial channel 242 which can be connected, depending on need, with a feed channel 243 of a secondary extruder. This is attained by moving a sleeve, which surrounds the hot runner and accommodates the feed channel 243, along the hot runner 241. Through this

movement, the feed channel 243 may selectively be aligned with the partial channel 242.

To prevent melt from migrating in the direction of the mold nest during filling of the main extruder by the secondary extruder, a pressure valve is positioned in the hot runner 241 immediately behind the location where the partial channel 242 branches off. The pressure valve is so dimensioned as to close at pressure applied by the secondary extruder and to open at a pressure applied by the main extruder.

Instead of the pressure valve 245, the injection molding process may also be controlled in such a manner that a sprue extends from the mold nest and remains in the hot runner 241 which extends to this previously described location. The sprue ensures that the melt does not flow in the direction of the mold nest. Only when the main extruder is filled in a desired manner will the workpiece be ejected with the sprue so that the hot runner 241 is cleared again.

A further control unit is shown in FIG. 25 and provided in the form of a pivoting nozzle 250 having an inlet 251 and an outlet 252 which are interconnected by a channel 253. The pivoting nozzle 250 is swingable about an axis 254 and secured by means of a fastening flange 255 to a tie rod 246 of the main extruder 257.

In the charging position (shown in FIG. 25), the inlet 252 points to the injection nozzle of the main extruder 257, while the inlet 251 points to a secondary extruder 258. In this position, the main extruder 257 and the secondary extruder 258 can be brought into contact with the inlet 251 and the outlet 252, respectively, and melt can be filled into the main extruder 257.

After charging the main extruder in a desired manner, the pivoting nozzle 250 is tilted upwards in the direction of the arrow, so that the path for the main extruder 257 is cleared and the latter can travel into its injection position.

According to another embodiment, the secondary extruder 258 may be securely fixed to the pivoting nozzle 250 and swung in unison with the latter.

As can be seen from FIGS. 24 and 25, the secondary extruder and the main extruder are arranged at an acute angle relative to one another or arranged in a V-shaped disposition. This enables a positioning of the control unit 240 and 250, respectively, in immediate proximity of the workpiece, so that the distances to be traveled by the main extruder can be minimized. As a result, the injection process can be carried out at increased speed.

FIG. 26 depicts a further possibility of increasing the working speed of an injection device which includes a main extruder having a nozzle 301 traversing a nozzle plate 302 as well as a portion of an adapter plate 303 through an injection

opening 304 to reach its injection position. The nozzle plate 302 denotes hereby an end of the mold space on the main extruder side, whereas the adapter plate 303 is a part arranged on the nozzle plate 302 for conforming to various molds or the like.

Provided in the adapter plate 303 is an opening 305 which terminates in the injection opening 304. Extending through the opening 305 is an extension piece 306 which leads from a secondary extruder to an outlet 307. Through moving the secondary extruder, the outlet 307 can be aligned with the injection opening 304 so that the main extruder can be charged from the secondary extruder when the nozzle 301 bears against the outlet 307.

For reasons of stability, the secondary extruder has an end which faces away from the outlet 307 and includes a lug 308 for engagement in a respective recess 309 of the adapter plate 303. For cleaning purposes, the recess 309 may be extended out of the adapter plate 303 so as to allow a discharge of excess melt.

As immediately evident, such an arrangement results in a minimized path to be traveled by the nozzle 301, when an adapter plate is provided in the mold space.

Standard components may be used as extension piece 306 so that this embodiment is further especially cost-efficient. To prevent an escape of melt, needle shut-offs may be provided at the outlet 307 and the nozzle 301.

Through the above-described arrangements and processes, especially pipes with a connection sleeve, hoses with fastening elements, brackets or plug connectors, pipes with flexible intermediate pieces or clutch pedals or other pedals, including lever gears and bar linkages with a soft element at the pedal pad, can also be made.

All this can be carried out in a single injection operation, thus significantly reducing the process time.

In practical application, the changeover from a first component to a further component, and, optionally, to a third, fourth etc. component, requires considerable experience, because the timing has to be exactly right. In order to ascertain the correct moment, sensors can be provided in the injection molding device and in particular in the mold or in an ejection bore for monitoring through pressure, temperature or ultrasound the filling of the cavity with the various plasticized materials. For better process monitoring, a pause can be introduced between the supply of different plasticized materials. In addition, the control of movement of the screw, i.e. the distance of material conveyed by the screw, can be used directly for controlling the slide gates. Instead of the distance, it is also

possible to measure the time elapsed from commencement of the injection procedure, to determine the correct moment for control of the slide gate. Finally, it is also possible to use the interior pressure of the mold as a parameter for the slide gate control.